Space Weather Technical Forecast

Issued on Thursday 26 September 2024 at 01:25 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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On the 24th of September, the way we distribute this forecast has changed and you will need to take action to continue receiving it. You should have received an email on the 4th of September explaining the steps required to do this. If you have already signed up to receive the forecast on our premium website, please disregard this message. If you haven't, or if you need help with the process, please contact moswoc@metoffice.gov.uk

Space Weather Forecast Headline: Chance of G1/Minor Geomagnetic Storm Day 1 (26 Sep). Chance of M-flares (R1-R2 Blackouts).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity is at Moderate levels with a flare peaking at M1.3 at 25/2312 UTC from AR3828 in the southwest quadrant.

Eight sunspot regions cover the visible disc. AR3836, in the southeast of the disc, is the largest region. This group has been reclassified as Cao/Beta and fore-shortening still makes accurate analysis tricky. AR3828, in the southwest is the second largest region, and is a uni-polar spot and continues to decay slowly. AR3833, a small region in the northwest, has seen recent emergence of spots in both the lead and trailing portions. AR3835, in the southeast close to centre disc, has shown further minor development in its southern portion. The remaining regions are either small, simple, or have shown little change since last analysis.

A Coronal Mass Ejection (CME) observed 22-23 Sep, directed primarily to the south and east, mostly away from Earth. This is now delayed but a glancing blow in the first few hours of Day 1 (26 Sep), is still possible. No other Earth-directed CMEs were observed.

Solar Wind / Geomagnetic Activity: The solar wind at slightly elevated levels 400-420km/s, reached Elevated levels of 500-520 km/s by 25/0550-0850 UTC. Solar winds have since eased and are at Slightly Elevated levels. Density, as measured by DSCOVR, was slightly above average, peaking at 19 ppcc at 25/0000 UTC. The Interplanetary Magnetic Field, Bt, was moderate for a time then eased back to Weak levels after 25/1200 UTC. The north-south component, Bz, has been predominantly weak to moderately negative (southward) fluctuating between +8/-11 nT. Phi angle has remained mostly positive (away from the Sun).

Geomagnetic activity has been mostly at Unsettled to Active levels (Kp 3-4), peaking at G1/Minor Geomagnetic Storm (Kp 5) between 25/0300-0600 UTC.

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Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 was at background levels. High energy electron flux (greater than 2MeV) observed by GOES16 was at background to moderate levels, peaking at 591 pppc at 25/1615 UTC. The associated 24-hour fluence was below the Active threshold. but on a recent rising trend. The 26/0000 UTC observation was 8.48e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is expected, with an ongoing chance of further isolated M-class flares.

Solar Wind / Geomagnetic Activity: The Coronal Mass Ejection (CME) following a flare off the southeast quadrant on 22 Sep may still give a glancing blow at Earth for the next few hours of Day 1 (26 Sep). Earth is also currently connected to a stream of coronal hole fast winds related to CH72/+. Solar winds are currently slightly elevated and are likely to remain at similar levels before gradually easing by the end of Day 2. If we experience a glancing blow from the aforementioned CME then solar winds could be potentially enhanced, back to Elevated levels, otherwise a slow return towards background levels is likely by Day 4 (29 Sep), when any influence from the HSS or CME arrivals is expected to have waned.

Geomagnetic activity is forecast to be Unsettled to Active (Kp 3-4) with further G1/Minor Storm intervals possible over the next few hours given the potential CME arrival. Geomagnetic activity is likely to gradually ease to Quiet to Unsettled (Kp 1-3) by the end of Day 1 (26 Sep). However, if we see more significant influence from the CME, then geomagnetic activity could become more significantly enhanced, with a slight chance of reaching G2-G3/Moderate-Strong Storm intervals. This is currently considered to be very low confidence.

Energetic Particles / Solar Radiation: High energy proton flux at GOES18 is likely to remain at background levels. High energy electron flux at GOES16 is likely to breach the active threshold by Day 2 at diurnal peak. This gives an increasing chance of Fluence reaching the Active (1e8 integrated pfu) threshold, towards the end of this guidance period.

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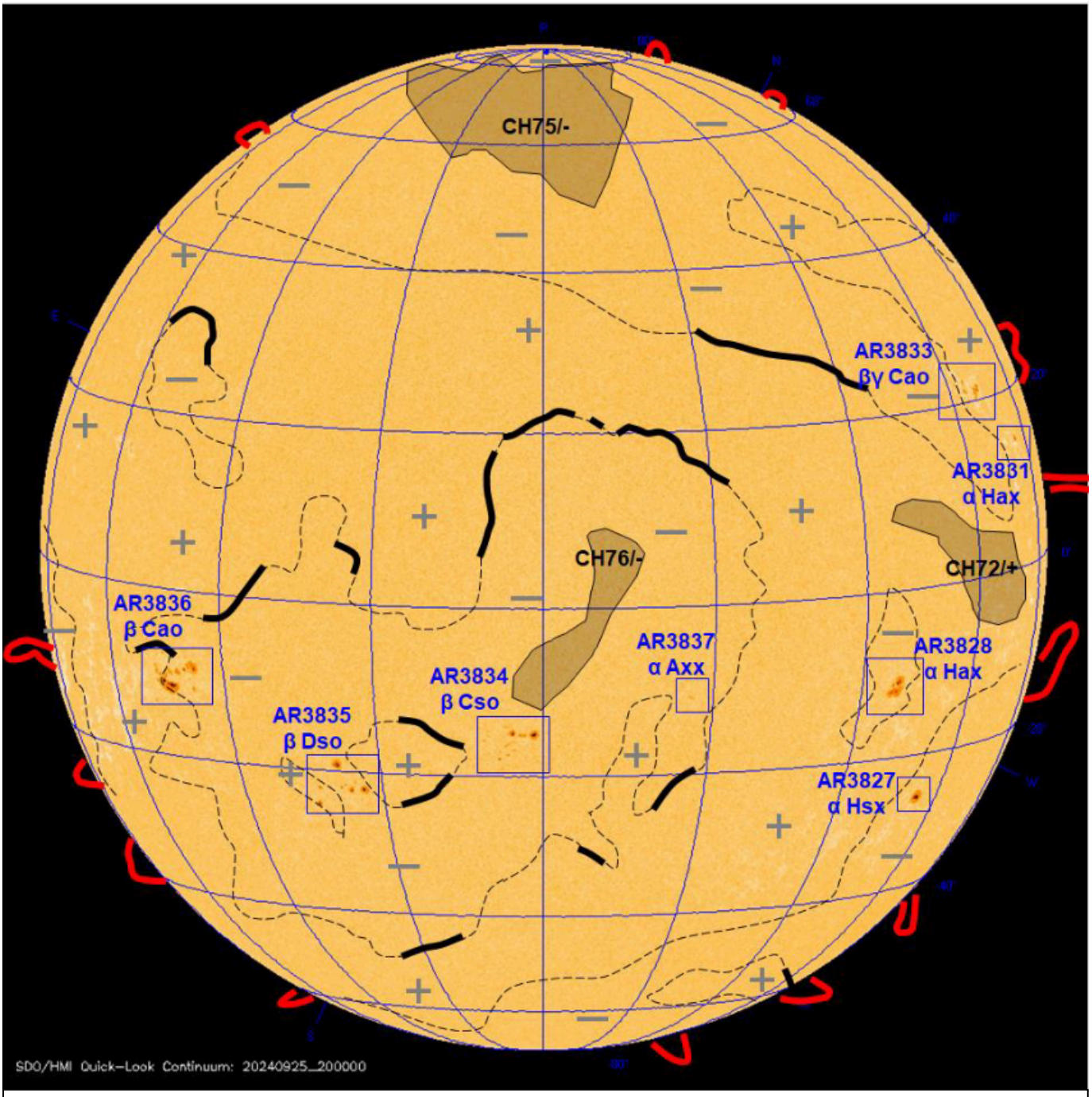
Figure 1: Solar Synoptic Map valid 2000 UTC, 25 September 2024.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

The partial halo CME which was observed following the M3.7 flare off the southeast quadrant on 22 Sep has been analysed. This CME is now delayed but for the next few hours of Day 1 (26 Sep) there may still be a glancing blow. The bulk of the material appears to be heading below and behind Earth's orbit. However, coronagraph imagery suggests that some shock effects could reach Earth. This may coincide with the ongoing connection to the fast wind from CH72/+ and lead to significant enhancement. However, this aspect of the forecast is considered to be low confidence.

Solar winds are currently at slightly elevated levels following connection to the HSS from CH72/+. Solar winds are likely to remain at this level through Day 1 (26 Sep) before returning towards background levels during Day 2 (27 Sep). The coronal hole is a persistent feature and is in a generally similar location when compared to previous rotation, but is stronger on SDO/AIA-211 imagery and extends slightly further east-west on this rotation. On the last rotation any impacts were largely swamped by ongoing CME effects. The MOSWOC Enlil forecast supports the ongoing enhancement from CH72/+, but is considered to be around 50-100 km/s too slow when compared to reality. Uncertainty lies in the forecast if Earth experiences a glancing blow from the aforementioned CME, as levels could then persist at, or close to, elevated levels until Day 2 (27 Sep).

The probability of a G1 during Day 1 (25 Sep) is now quite low at 20% netic Storm interval. Geomagnetic activity is forecast to be Unsettled to Active (Kp 3-4) initially with the likelihood of Active to G1/Minor Storm intervals over the next few hours with the potential CME arrival. However, given the favourable geomagnetic environment and proximity to the equinox, then geomagnetic activity could become more significantly enhanced, with a slight chance of reaching a G2-G3/Moderate-Strong Storm interval. This is currently considered to be low confidence. Geomagnetic activity is likely to gradually ease to Quiet to Unsettled.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	Yes	20	5	1	1
Strong	**G3**	No	5	1	1	1
Severe	**G4**	No	1	1	1	1
Extreme	**G5**	No	1	1	1	1

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Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
2024-09-23 00:31Z	Partial	Filament	SE	1195 km/s	2024-09-25 12:00Z	M3.7 from filament eruption between AR3834 and AR3835. Middle ground of two separate fits

Figure 2: MOSWOC Enlil showing potential for CME arrival in next few hours.

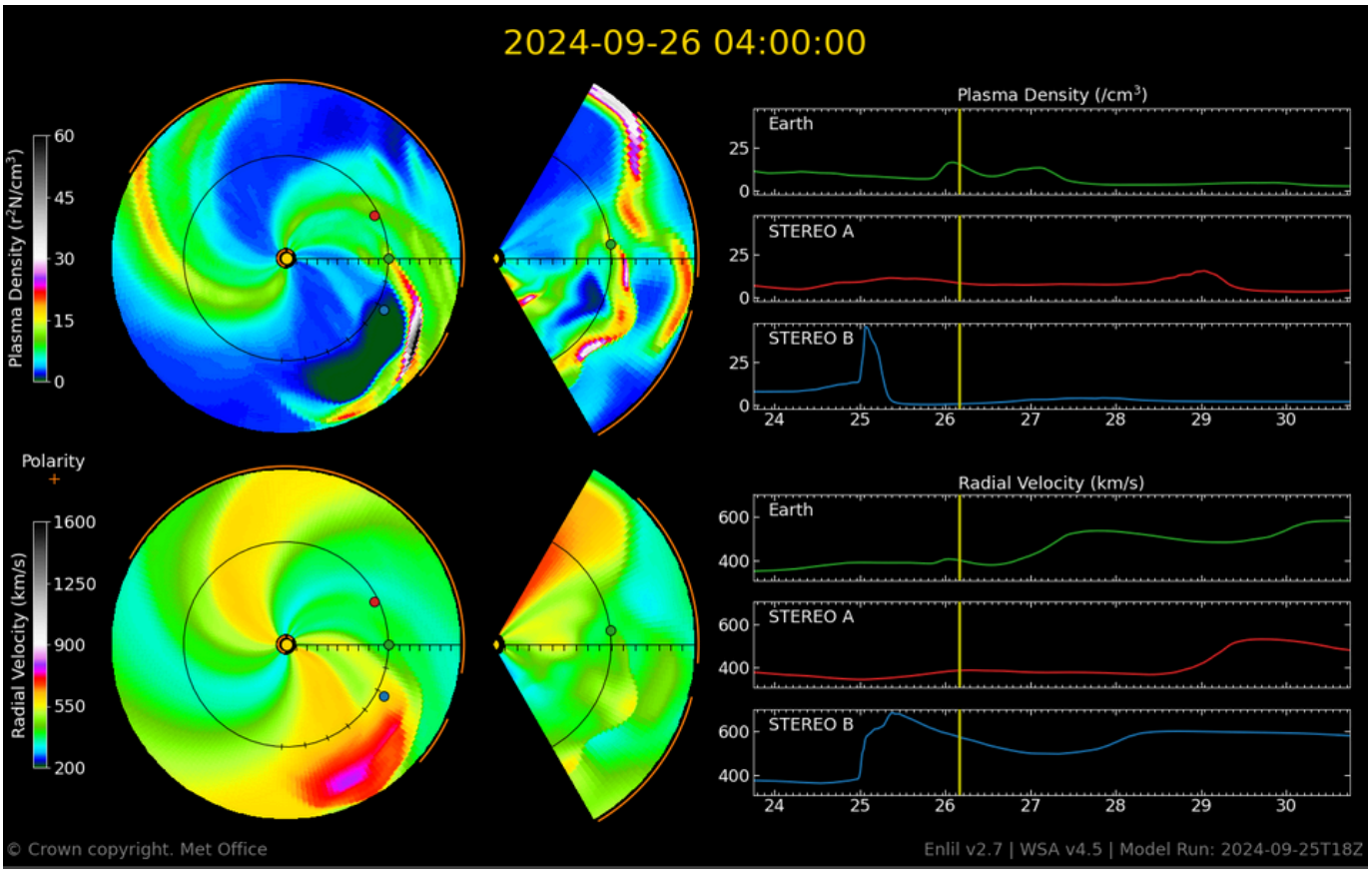

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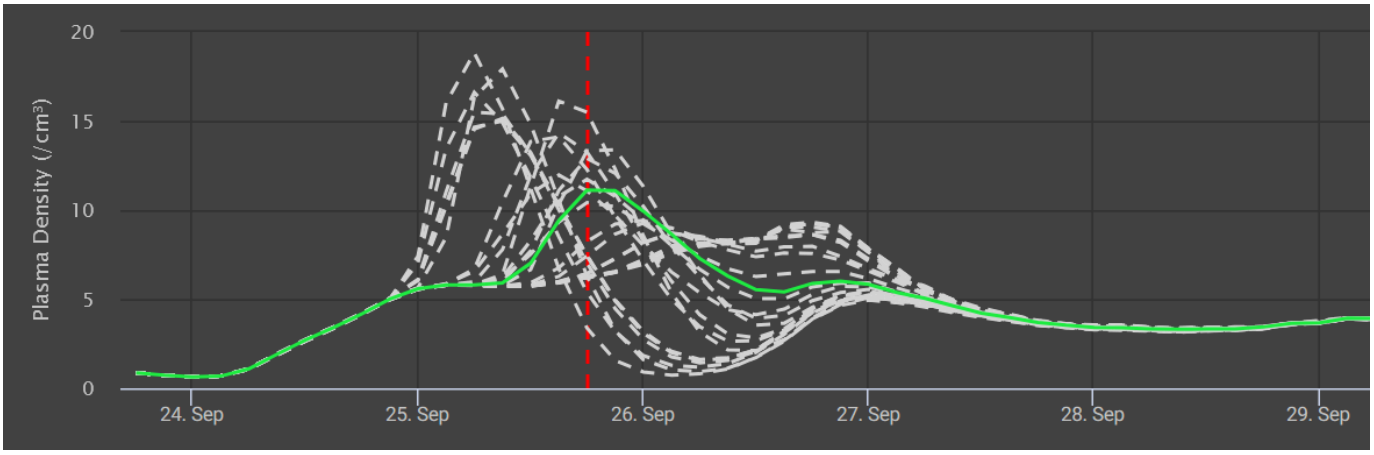
Figure 3: MOSWOC Enlil ensemble showing potential for CME arrival in next few hours.



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Radio Blackouts - X-Ray Flares

Activity is Moderate with a peak flare of M1.3 at 25/2312 UTC from AR3828 in the southwest. Activity is expected to be at Low to Moderate levels, with a Chance of isolated M-class flares, most likely emanating from AR3833 AR3828, or AR3836. AR3836 appears to exhibit notable looping in SDO imagery that extends beyond the eastern limb. As such, this region remains one to watch for the possibility of more significant flare activity.

Eight sunspot regions cover the visible disc. AR3836, in the southeast of the disc, is the largest region. his group has been reclassified as Cao/Beta and fore-shoertening still makes accurate analysis tricky. AR3828, in the southwest is the second largest region, and is a uni-polar spot and continues to decay slowly. AR3833, a small region in the northwest, has seen recent emergence of spots in both the lead and trailing portions. AR3835, in the southeast close to centre disc, has shown further minor development in its southern portion. The remaining regions are either small, simple, or have shown little change since last analysis.

Far-sided imagery suggests further regions are due to rotate onto the disc during the forecast period, especially towards the southeast quadrant. This is also evident in the SDO/AIA 171 imagery, with areas of brightness and magnetic looping seen on, or just beyond the east limb, in both the northern and southern hemisphere.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	No	30	30	40	40
Very Active	R3-R5 (X Class)	No	5	5	5	5

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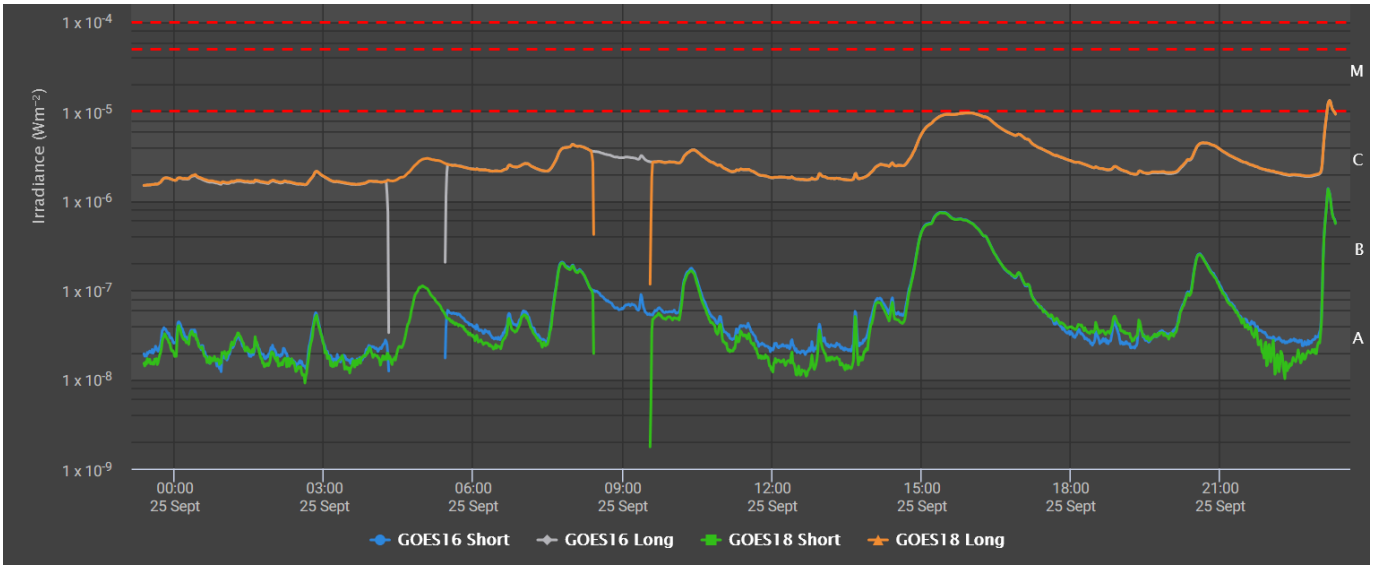
Figure 4: Latest X-ray flux plot at GEO from GOES, with one M-class flare observed.



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Solar Radiation Storms (High Energy Protons)

High energy proton flux at GOES18 is forecast to persist at background levels, with only a very slight chance of rising above the S1/Minor Radiation Storm threshold.

The majority of the sunspots on the disc are either small or simple with only modest contributions to flare probabilities from most spots, with AR3828 and AR3833 currently in the most favourable position to produce any proton response. There is a non-zero, albeit very low chance of observable protons from any significant filament eruption, given the number and size of notable filaments currently on the disc.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons (≥ 2MeV)

GOES-16 high energy electron flux is now at background to moderate levels. Due to potential HSS and CME effects, the subsequent increased solar wind pressure is expected to compress the radiation belts once again and suppress observed flux values in the short term. There is potential for the recovery and increase in flux later in the period, after CME and HSS effects have subsided.

The associated 24 hour fluence reached the Active (1e8 integrated pfu) level during 22-23 Sep but has since dropped below the threshold,. Confidence is low during this period. High energy electron flux at GOES16 is likely to breach the active threshold by Day 2 at diurnal peak. This gives an increasing chance of Fluence reaching the Active (1e8 integrated pfu) threshold, towards the end of this guidance period.

GEO Electron Environment Probability (Exceedance)	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ 1×10^{8}**	No	1	1	1	5
Very Active	**≥ 2 MeV ≥ 1×10^{9}**	No	1	1	1	1

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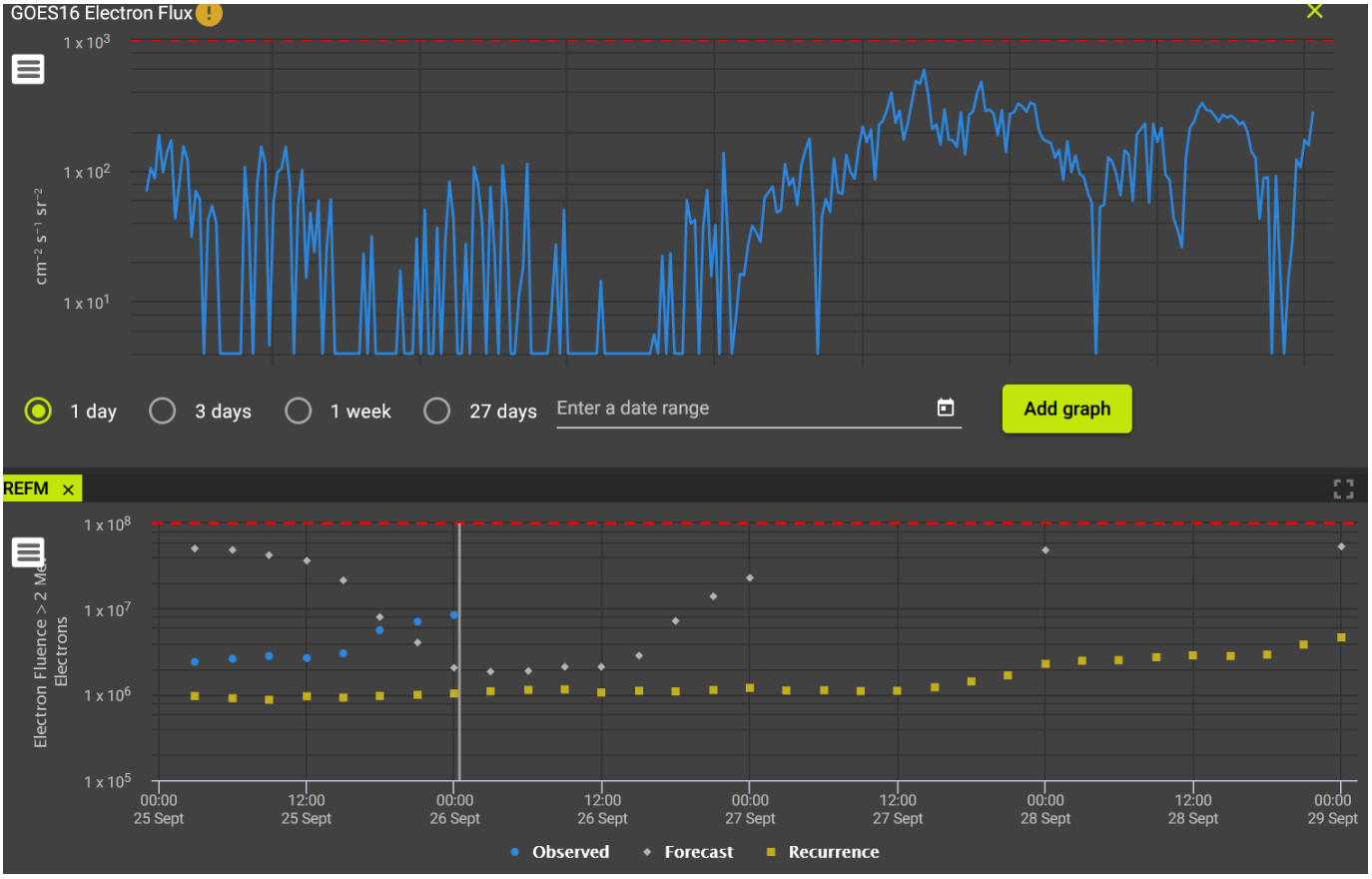
Figure 5: High energy electron flux at GEO from GOES satellites and Met Office REFM output shoing a rising trend.



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